



DOE Office of Industrial Technologies

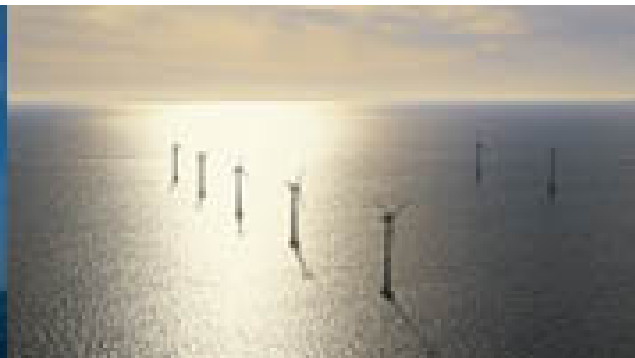
Wind Power Development

March 19, 2003

Steven Palomo

US Dept. of Energy

Wind Powering America





OVERVIEW

- State of Industry
- State of Technology
- Trends/Opportunities
- Issues
- Future of Industry?





What is Wind Power?

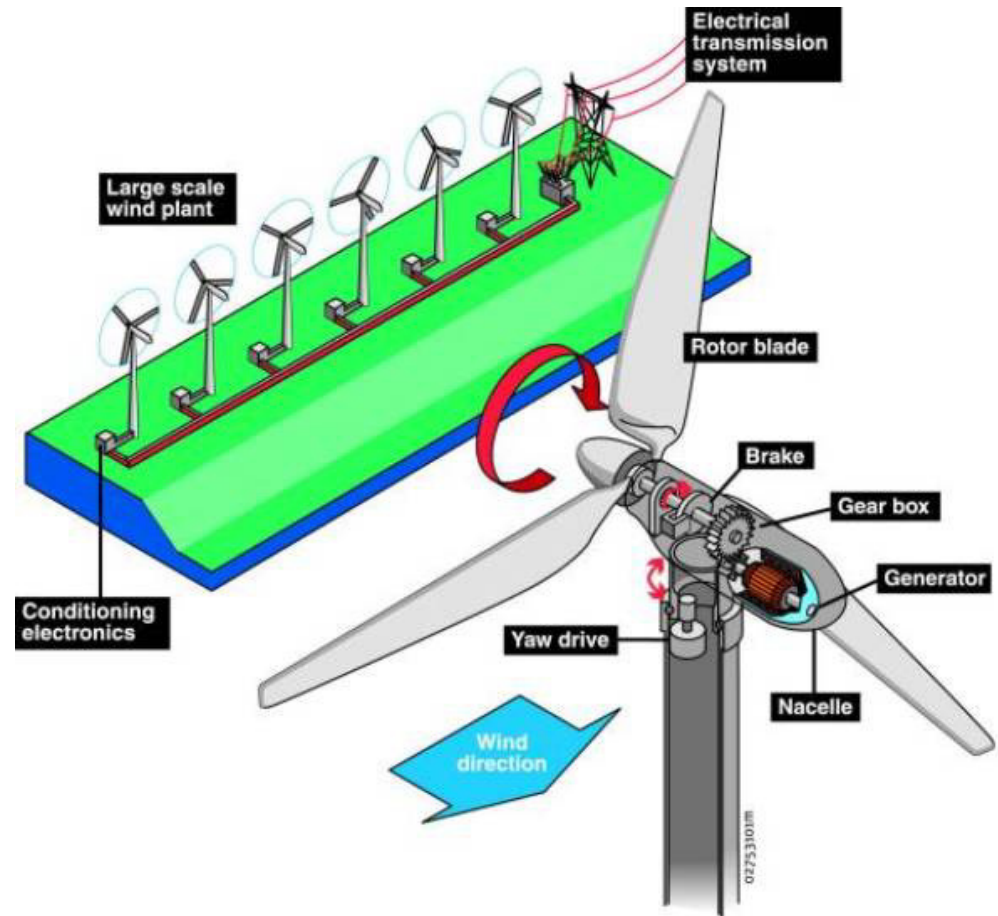
- Not a new concept
- Dates to ancient civilizations
- Principles the same





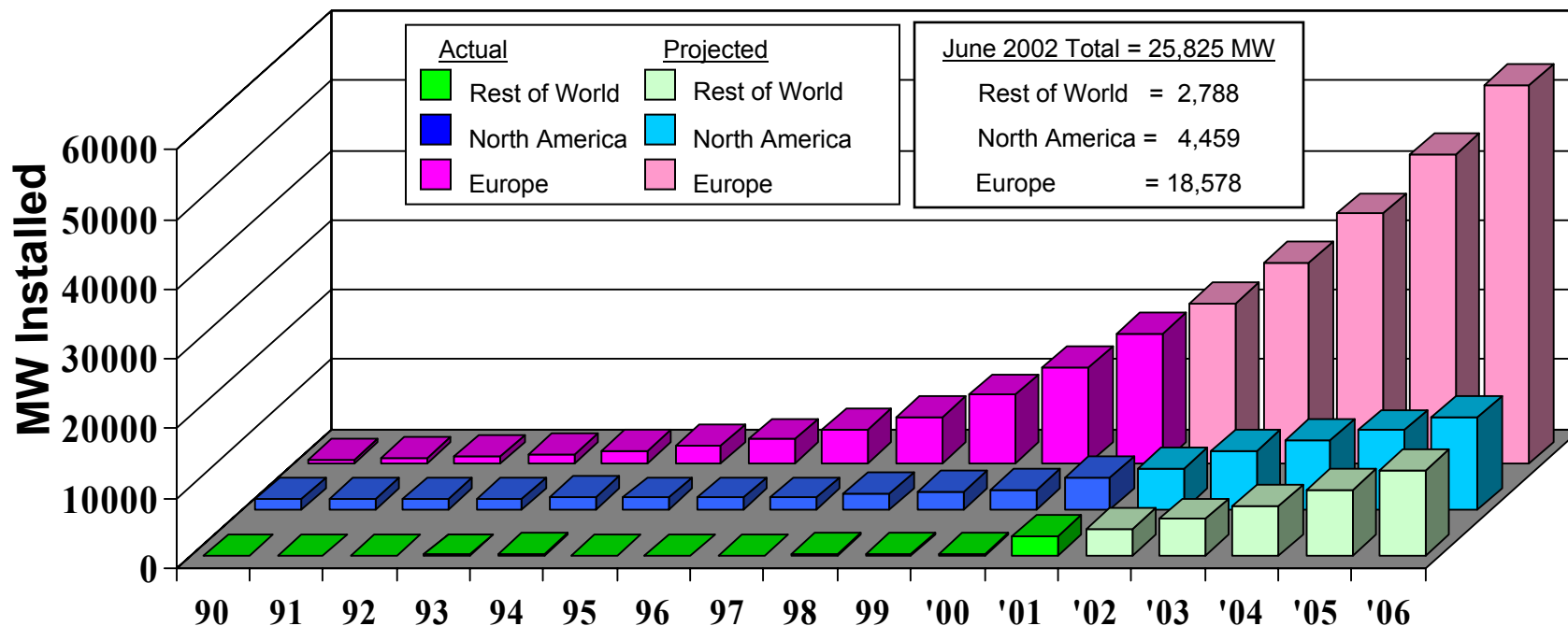
Wind Energy Technology

$$P = A \times \rho V^3 / 2$$



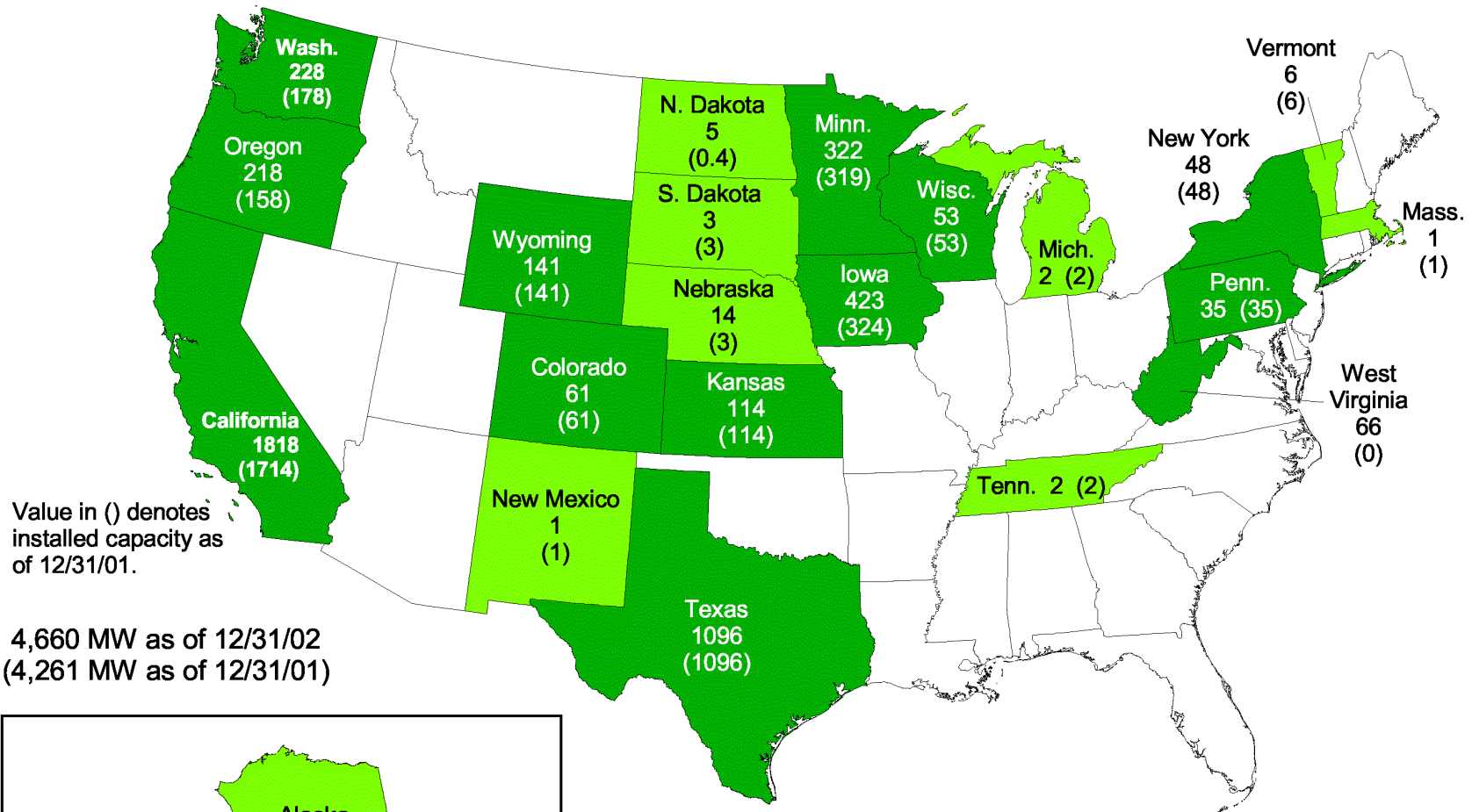


Growth of Wind Energy Capacity Worldwide



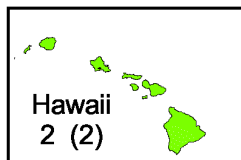
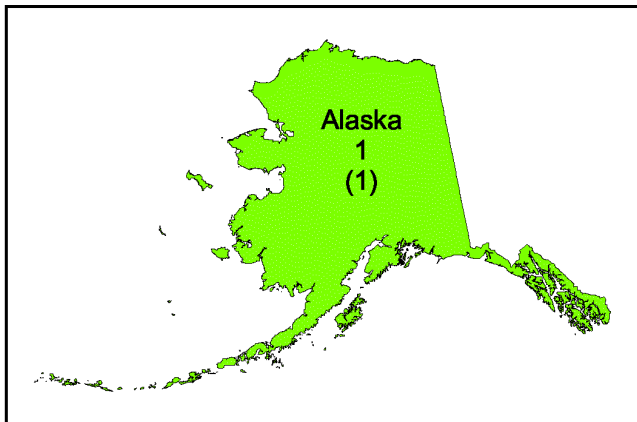
Sources: BTM Consult Aps, March 2002
Windpower Monthly, June 2002

Current Installed Wind Power Capacity (MW)



Value in () denotes
installed capacity as
of 12/31/01.

4,660 MW as of 12/31/02
(4,261 MW as of 12/31/01)



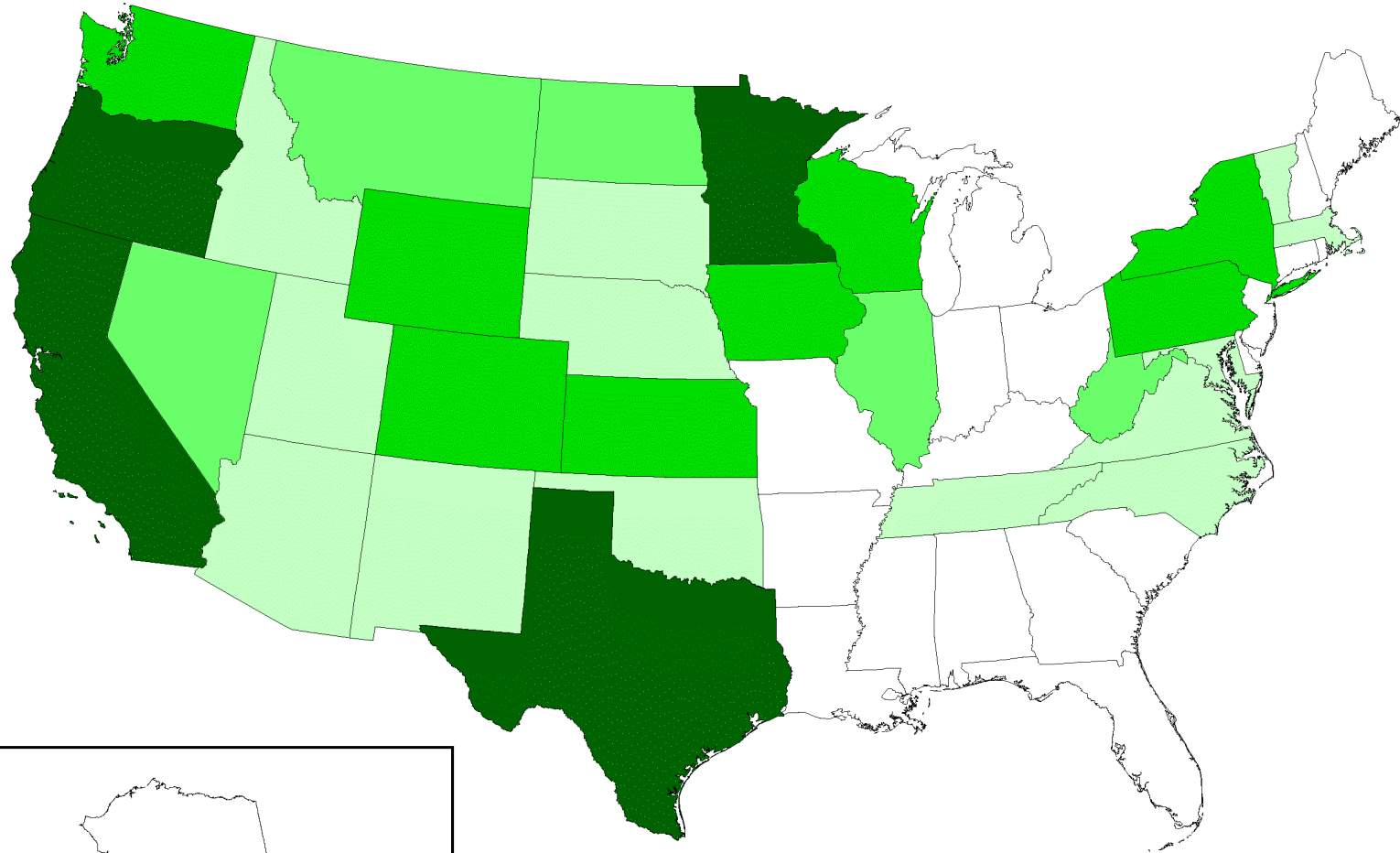
Wind Power Capacity Megawatts (MW)

- 20 - 2000
- 1 - 20

U.S. Department of Energy
National Renewable Energy Laboratory



United States - States with at Least 20 MW of Installed Capacity by 2005



Year Reached or
Projected to Reach

- 1998
- 2001
- 2002 - 2003
- 2004 - 2005

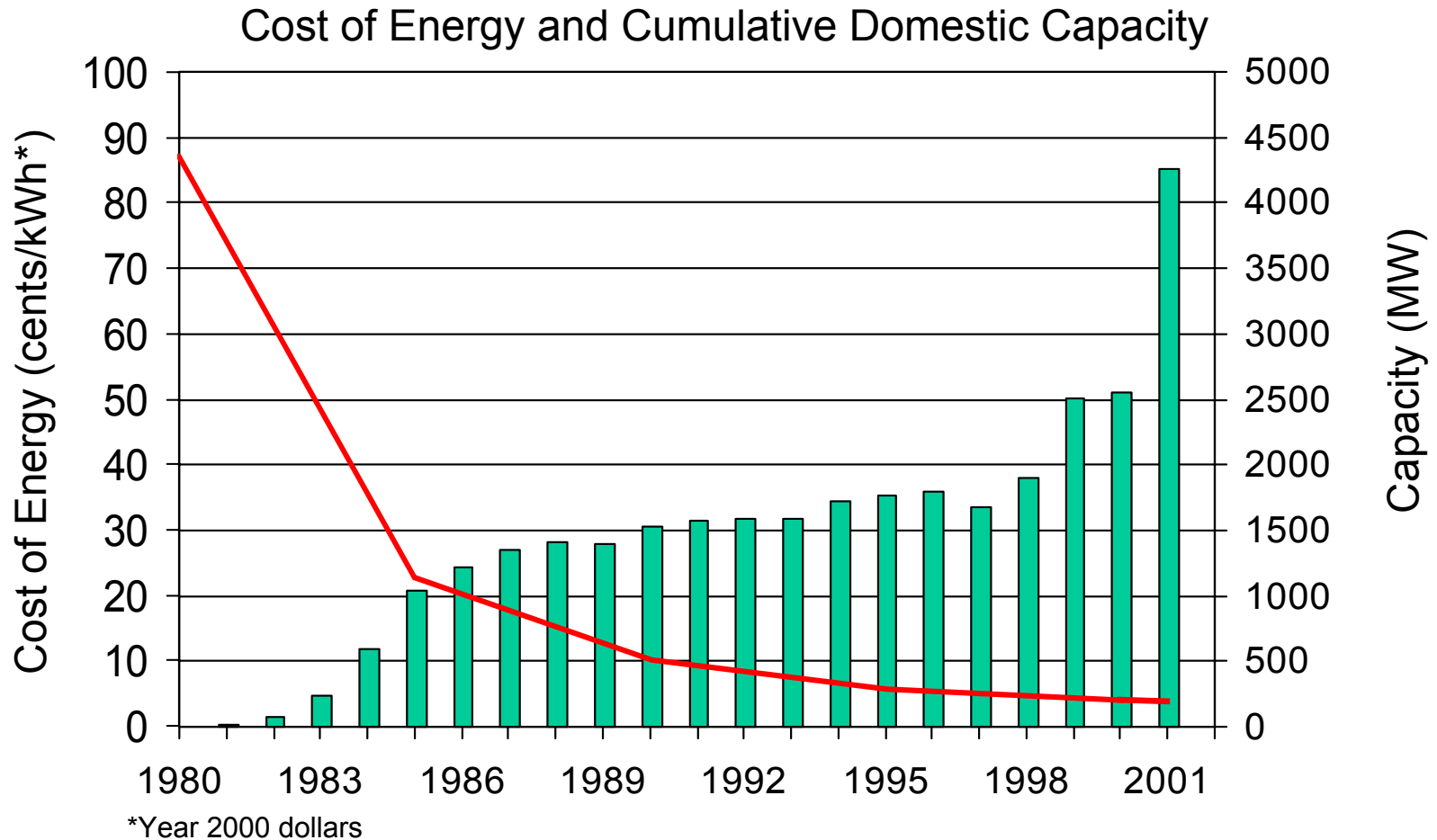
U.S. Department of Energy
National Renewable Energy Laboratory



28-MAR-2002 1.1.12



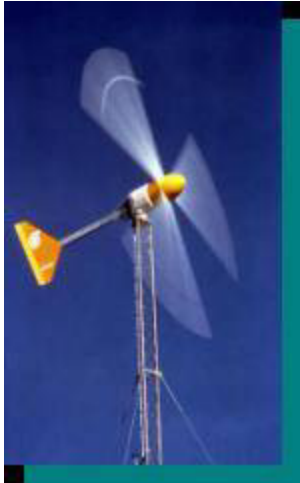
Cost of Energy is Falling



Increased Turbine Size - R&D Advances - Manufacturing Improvements



Sizes and Applications



Small (≤ 10 kW)

- Homes
- Farms
- Remote Applications

(e.g. water pumping, telecom sites, icemaking)



Intermediate (10-250 kW)

- Village Power
- Hybrid Systems
- Distributed Power

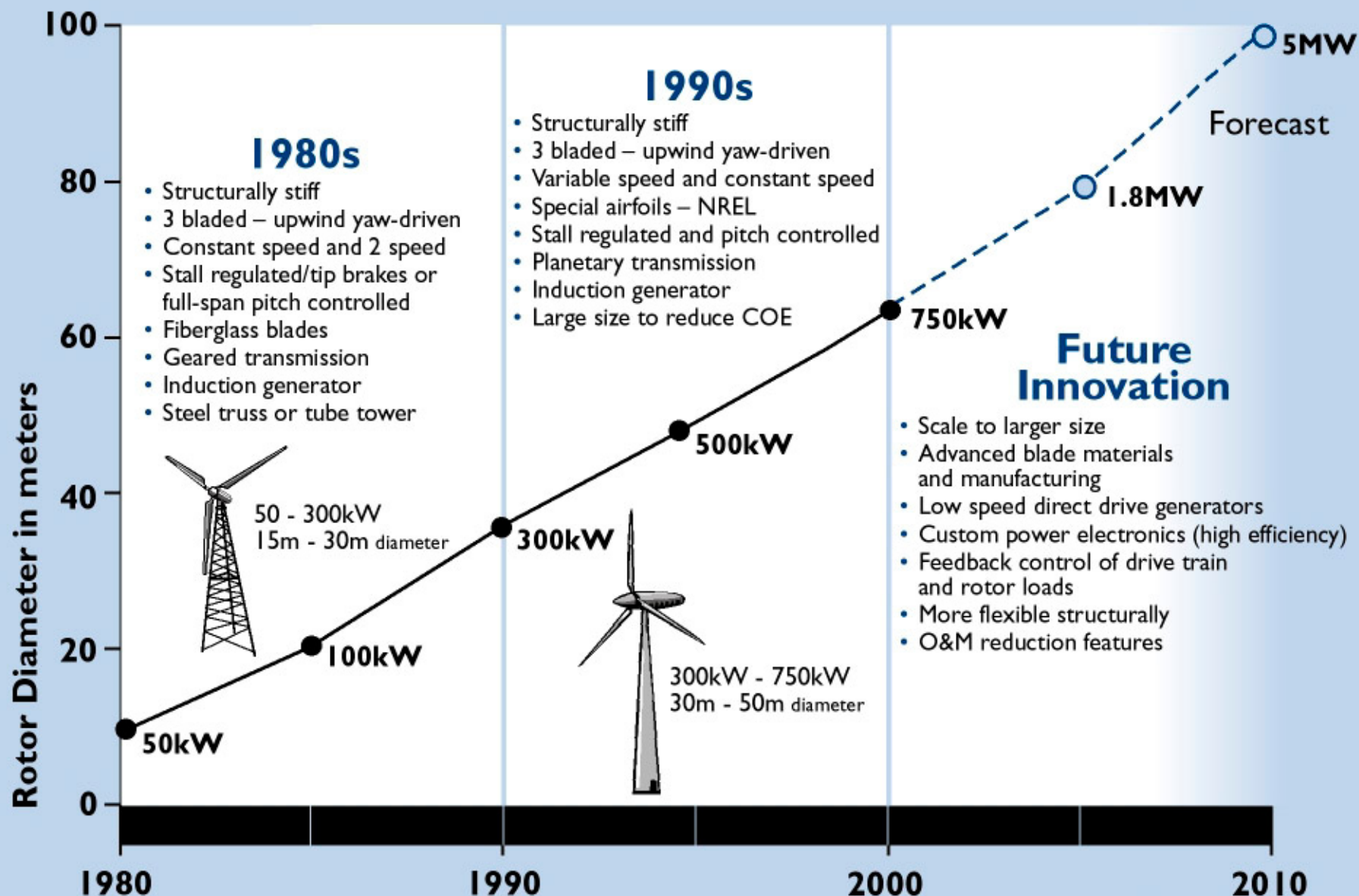


Large (250 kW - 2+MW)

- Central Station Wind Farms
- Distributed Power

**NREL**

THE EVOLUTION OF COMMERCIAL U.S. WIND TECHNOLOGY





Specifications / Performance


- 98% Availability
- 20-25 yr Life
- Composite Blades
- Variable Pitch Blades
- Capacity Factor (30-40%)
- Ancillary Service Costs
- 80-90ft Blades
- 190-220ft Hub Height
- 30-50 tons
- Nacelle can hold Suburban






Wind – Industrial Sector Partnerships

- Opportunities:
 - Sales of advanced materials and processes
 - On-site developments
 - Investments in Wind Companies/projects
 - Land Lease Arrangements
 - Green Power/Green Tags purchases
 - New Markets (DisGen, Wind / Hydrogen)
- Benefits:
 - Meet Distributed Energy Needs
 - Stabilize Energy Prices
 - Low-cost Environmental Compliance
 - Corporate & Community Leadership



Supplying Advanced
Materials & Components
for Wind Power Systems

October 2001



Sponsored by

U.S. Department of Energy
Office of Industrial Technologies
Office of Power Technologies

Prepared by

Mark Ellis
Energetics, Inc.

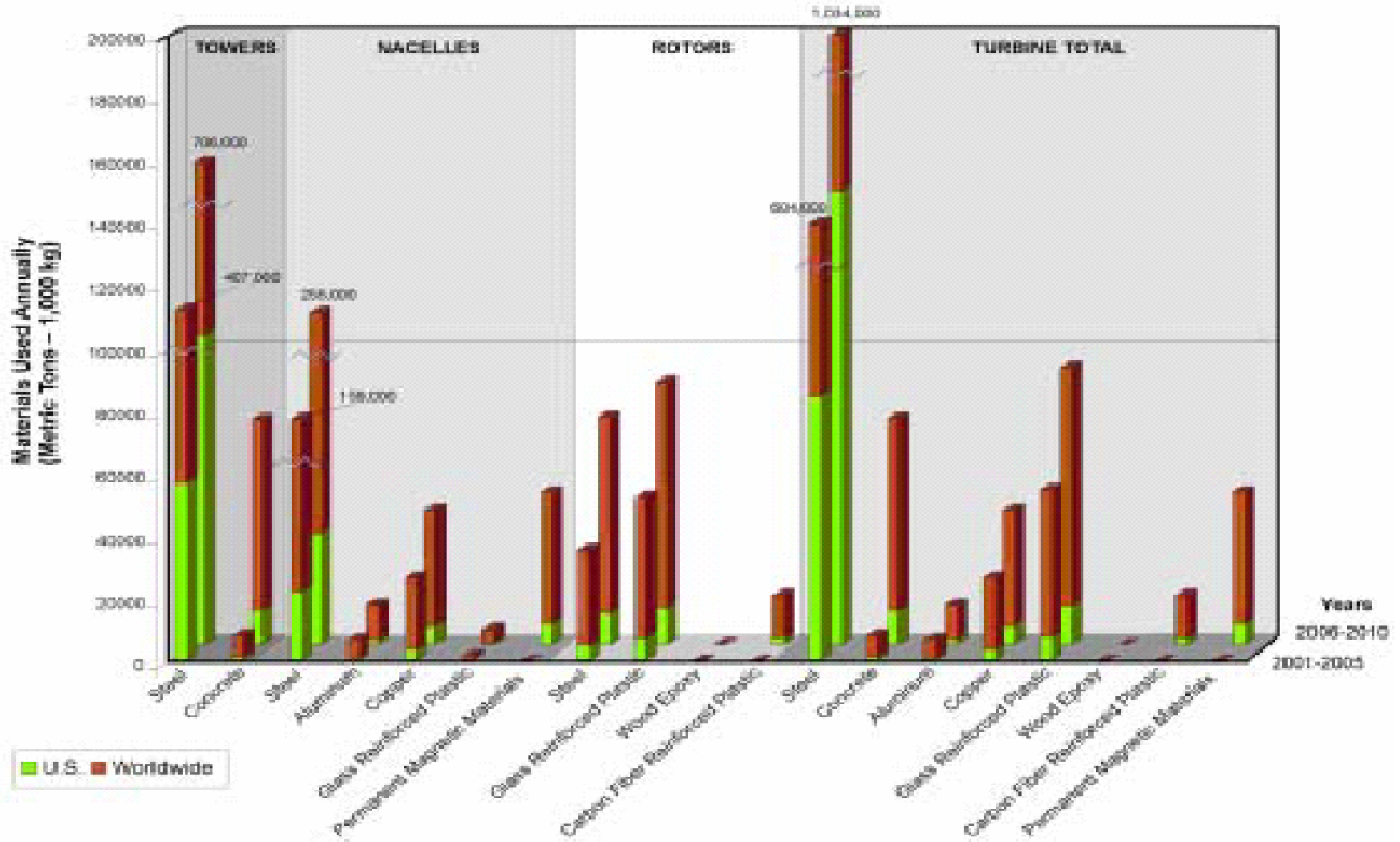
Jack Eisenhower
Energetics, Inc.



Growing Market for Materials

(Dan Ancona and Jim McVeigh, Princeton Energy Resources International, 2001)

Wind Turbine Materials Usage

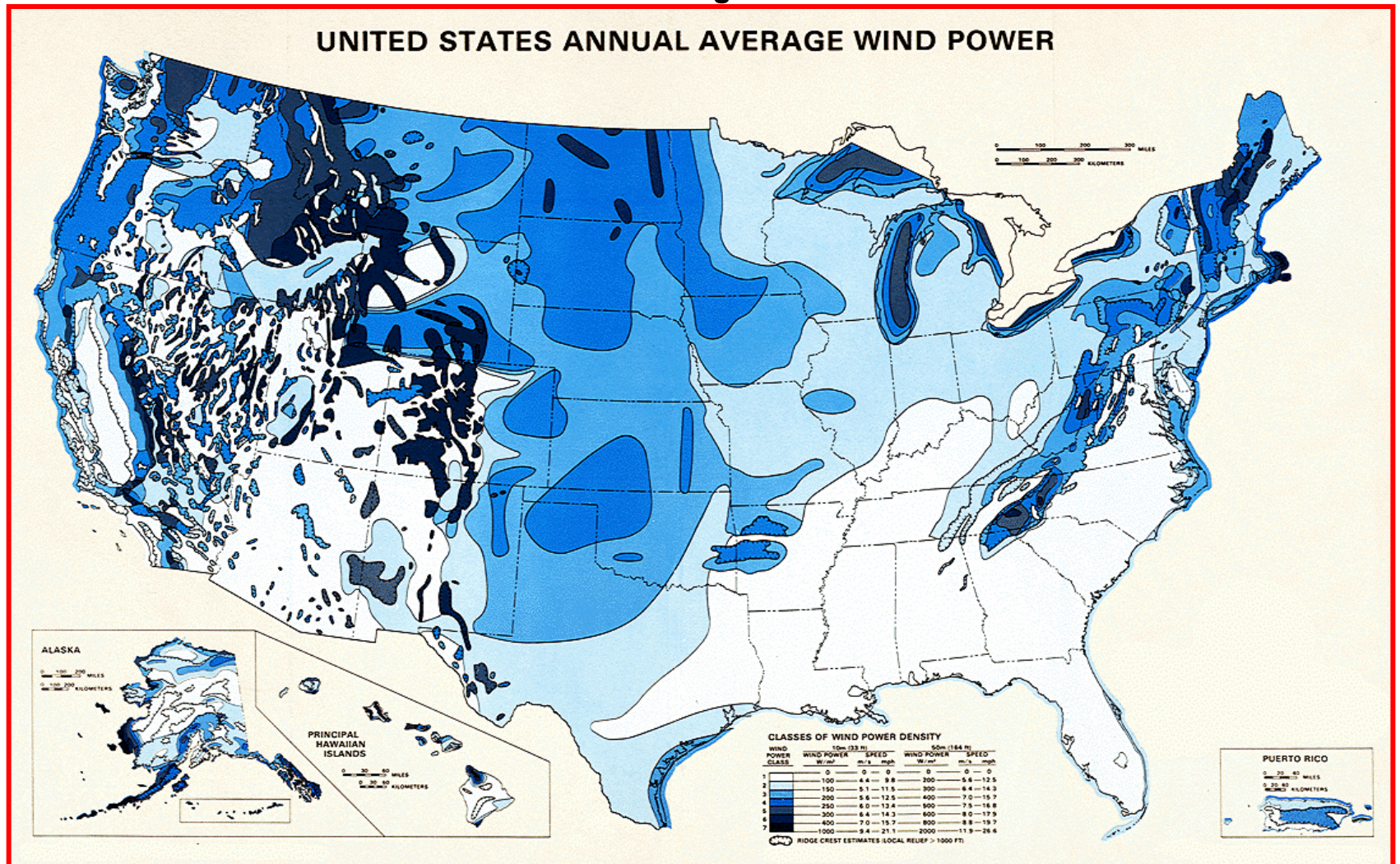




Low Speed Wind Technology

Darker shades indicate higher wind resource

UNITED STATES ANNUAL AVERAGE WIND POWER





Large Turbine Cost Reduction Potential

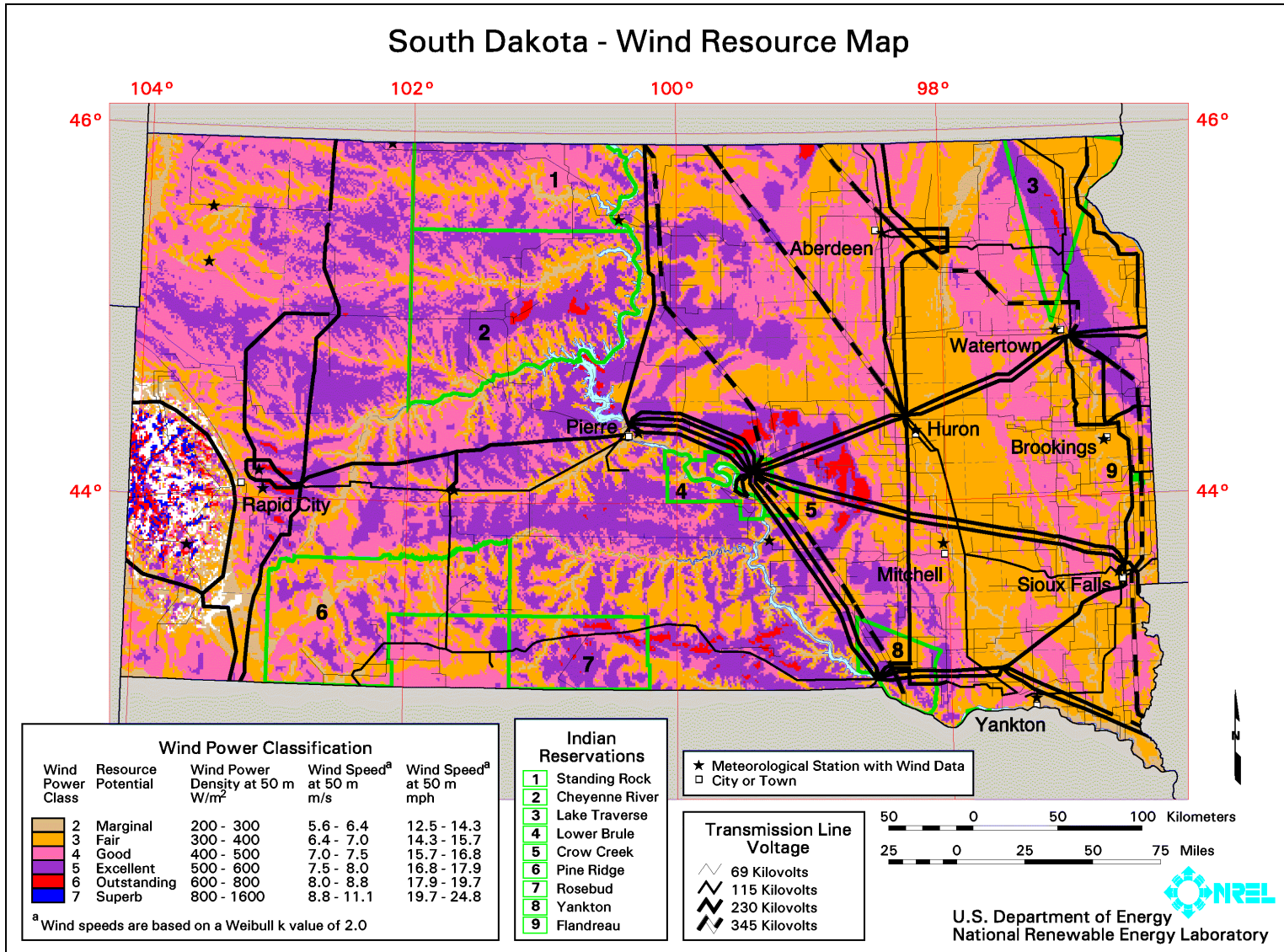
Technology Improvements

Estimated COE Improvement

• Larger-scale 2 - 5MW - (rotors up to 120m)	0% \pm 5%
• Advanced rotors and controls – (flexible, low-solidity, higher speed, hybrid carbon-glass and advanced and innovative designs)	-15% \pm 7%
• Advanced drive train concepts - (Hybrid drive trains with low-speed PM generators and other innovative designs including reduced cost PE)	-10% \pm 7%
• New tower concepts - (taller, modular, field assembled, load feedback control)	-2% \pm 5%
• Improved availability and reduced losses - (better controls, siting and improved availability)	-5% \pm 3%
• Manufacturing improvements - (new manufacturing methods, volume production and learning effects)	-7% \pm 3%
• Region and site tailored designs (tailoring of larger 100MW wind farm turbine designs to unique sites)	-5% \pm 2%
	<hr/>
	-44% \pm 32%



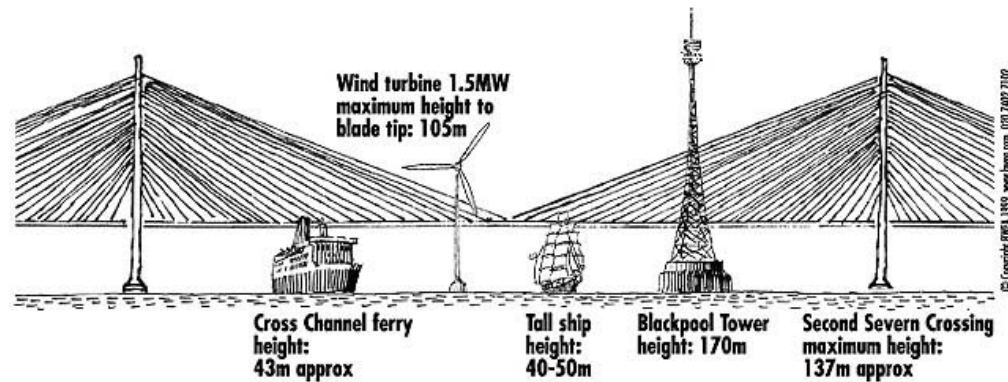
Wind Must Be in “Right Place”





Offshore Wind

- Strong Wind Resource
- 20 – 30% Cost Increase
- Gravity / Monopile Foundations
- >100ft Foundation Depth
- 3-5 Miles Off Shore
- Environment Impacts
- Aesthetics







Wind's Future

- Issues:
 - Economics
 - Intermittency
 - Transmission
 - Utility Operations Impacts
 - Aesthetics, Noise
 - Avian
- Benefits:
 - Stabilize Energy Prices
 - Abundant / Limitless US Resource
 - Safe, non-target
 - Pollution Free
 - Stretch Existing Fossil Fuels
- Markets:
 - Distributed Generation
 - Wind / Hydrogen
 - Wind / Hydro
 - Offshore Wind
- Final Analysis
 - Wind Market will grow... but how much?
 - Legislation (RPS, PTC, State Tax), public, utility acceptance.





Key Contacts:

- eren.doe.gov
- oit.doe.gov
- nrel.gov/wind
- awea.org
- uwig.org
- Windpoweringamerica.gov
- Steve.palomo@ee.doe.gov, 303-275-4838

